Auswalzungen); (2) an intermediate layer of folding and dislocation recognizable by rotation and inversion of strata (*Faltung mit Faltungverwerfungen, kenntlich durch Auswalzungen und Umkehrungen der Schichtfolge*); and (3) a layer of quite plastic material with primary sliding without rotation or inversion (*ein Niveau mit primären Ueberschiebungen ohne Auswalzungen und Schichtumkehrungen*).

The conditions represented by the surface layer are naturally exposed only where there has been little denudation, and we are referred to the North German plain, where a gently undulating surface is succeeded, at no great depth below the surface, by an extraordinarily involved series of rocks, very puzzling to decipher. The second layer, contorted and faulted so as almost to defy analysis, is laid bare in the Appalachian range, and in the Alps; a double fold peculiarly characteristic forming the Glarus Alps, here specially described. The third and last layer, exposed by practically destructive denudation, is represented by the great thrust-planes of the north-west highlands of Scotland. Each of these layers, as is indicated by the experiments, glides almost insensibly into the one next to it. Prof. Penck here specially describes his personal examination of the second and third.

TO FIND THE ANGLES FROM THE VERTEX OF THE MOON FOR AN OCCULTATION PREDICTED BY MAJOR GRANT'S APPROXIMATE METHOD.*

By E. A. REEVES, F.R.A.S.

In the number of the *Geographical Journal* for June, 1896, there appeared an excellent paper by Major S. C. N. Grant, R.E., in which he describes his graphic and very practical method of predicting the circumstances of an occultation with sufficient accuracy for the purposes of an explorer. This method, although it does not attempt at great precision, will, with moderate care in working, enable a person to determine whether an occultation which is given in the 'Nautical Almanac' will be visible in any place on the Earth's surface of which the latitude and approximate longitude is known, and, if so, will give, within a few minutes, the time of its occurrence. It also provides the means of ascertaining the angle, as measured from the *north point* of the moon, of immersion and emersion. Unless, however, an equatorially-mounted telescope should happen to be used, which can rarely be the case, it is impossible to say, with anything like certainty, where the north point of the moon is. What an explorer, who usually carries a telescope with the ordinary alt-azimuth mounting, requires is some means of finding the angles of immersion and emersion from the *vertex* of the moon, and the following is a simple method of approximately ascertaining these angles.

Upon the diagram showing the circumstances of the occultation already plotted according to Major Grant's method, the positions of the moon's centre, as effected by parallax, at the whole hours selected, and at immersion and emersion, are shown, and the perpendicular lines on the paper represent the celestial meridians, or lines running in a true north and south direction.

In the example here given, let it be supposed that we require to find the approximate angle from the vertex at immersion, which it has been ascertained will take place at $10^h\ 19^m$. The nearest hour to this is, of course, 10^h, for which

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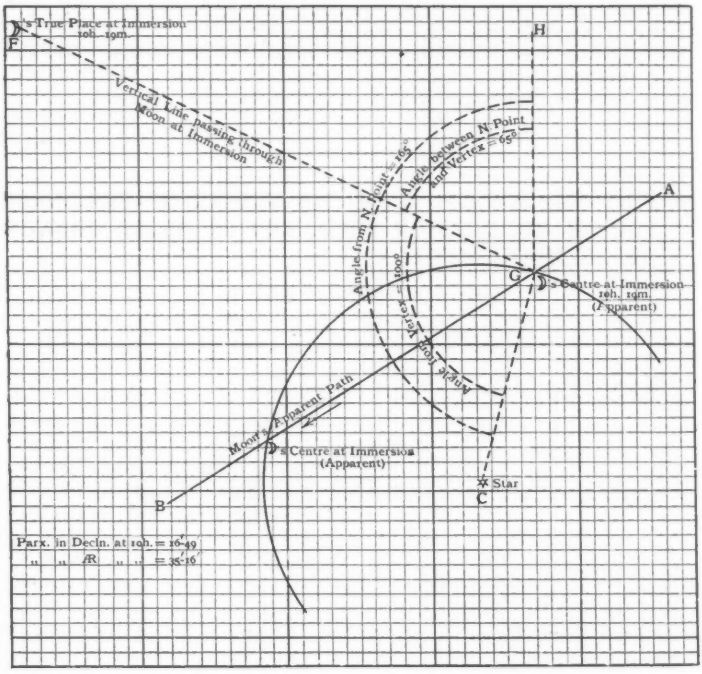
* An appendix to Major S. C. N. Grant's Approximate Method of predicting the Circumstances of an Occultation (*Geog. Jour.*, vol. vii. p. 649).

we have found the parallax in declination to be 16′ 49″, and the parallax in right ascension, 35′ 16″. With these quantities we can turn to the diagram (corresponding with the second in Major Grant's paper) and proceed as follows: Mark off on the diagram the true position of the moon at the time of immersion by means of the parallaxes in declination and right ascension previously found, thus: Taking, as before, each small square on the diagram to represent one minute of arc, mark off the required number ($16\frac{3}{4}$ nearly), counting up from the apparent place of the moon at immersion ($10^h\ 19^m$). (We count *up* in this case, as the true declination of the moon is further north than the prepared or apparent declination; if the opposite had been the case, we should count *down*.) Make a mark at this point,



and then count off to the east or west (left or right) the number of squares and parts of squares equal to the minutes and seconds (in arc) in the parallax in right ascension for the first hour (10^h), also previously computed, and mark this spot clearly. This is shown by F. (When the hour angle is west count off to the left, and when east to the right, of the north-and-south line passing through the moon's apparent place at immersion.) This point, F, will approximately represent the *true* place of the moon at immersion. Next, with a ruler on the point F and the apparent place of the moon at immersion, G, draw a line, FG, connecting these two points. Then FG represents a portion of a great circle passing through the moon's centre and the zenith; and the angle FGC is the angle of immersion, measured from the vertex of the moon.

To find the angle at emersion, all that is required is to go through the same process again, using the parallaxes worked out for the next hour (11^h), and measuring from the moon's apparent place at emersion.

When the parallaxes in declination and right ascension do not vary much between the two hours for which they have been ascertained by Major Grant's method, it will be near enough for practical purposes to use the quantities as they are worked out for the nearest hour without applying any correction for the change during the elapsed interval of time; but when the difference is considerable, a correction should be made, which can be done very readily by applying the proportional part for the elapsed interval, ascertained by means of the change in one hour, which is already given. Then, with these corrected parallaxes, turn to the diagram and proceed as previously described. The resulting angle from the vertex in the present case would, of course, be nearer the truth if this correction had been made; but the difference is only about 2°, which, from a practical point of view, is unimportant.

The angles from the vertex can be found in this way in a few minutes, and, although the results may not be exact, they are quite near enough for the purposes of an explorer, who only wants to know at what part of the moon's disc to direct his telescope.*

The last four lines of the calculation should therefore be altered as follows:—

Star's right ascension	$3^h\ 29^m\ 45^s$	Declination ...	23° 26′ 41″ N.
Moon at 18^h	$3^h\ 29^m\ 28^s$	Declination ...	23° 9′ 14″ N.
Difference in time ...	17^s		
„ „ are ...	4′ 15″		17′ 27″

A diagram drawn in accordance with the calculation as printed in Major Grant's paper shows that, since the circle drawn from the star as centre, with a radius equal to the moon's semi-diameter, does not cut the line of motion of the moon's centre, no occultation would take place.

THE GEOGRAPHICAL ASSOCIATION.

The Annual Meeting was held in the hall of the Society of Arts, on December 23, Mr. Douglas W. Freshfield, President, in the chair. The *Annual Report* drew attention to the important step taken by the Victoria University in making geography a University subject, by including it in the Preliminary Examination in place of physiography. Reference was made to the appearance of Dr. H. R. Mill's most useful book, 'Hints to Teachers and Students on the Choice of Geographical Books,' a work undertaken at the special request of the Committee. Applications for a *Syllabus* of geographical teaching having been from time to time received, the Committee had, after much consideration, decided to print and circulate for criticism, (1) a general syllabus for Secondary schools; and (2) a scheme of study setting forth the minimum of geographical knowledge that might fairly be required of a boy on leaving the Preparatory school at the age of fourteen. The first experimental copies of coloured *lantern slides*, made by a new process, on which the hon. secretary

* On the diagram at the end of Major Grant's paper, the position of the star, S, has been erroneously plotted, and to bring the calculation in his paper in harmony with the diagram, we must assume the right ascension and declination of the star occulted to be $3^h\ 29^m\ 45^s$ and 23° 26′ 41″ N. respectively.